JB10:

RRS John Biscoe (leg 3) Scotia and Weddell Seas Physical Oceanography February - March 1990

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Natural Environment Research Council

British Antarctic Survey

Cruise report

R.R.S. John Biscoe

Cruise JB10 Leg 3

February to March 1990

Physical Oceanography
in the Scotia Sea and Weddell Sea

April 1990

B.A.S. Reference No. ....

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RRS JOHN BISCOE CRUISE REPORT

CRUISE JB10 LEG 3

FEBRUARY TO MARCH 1990

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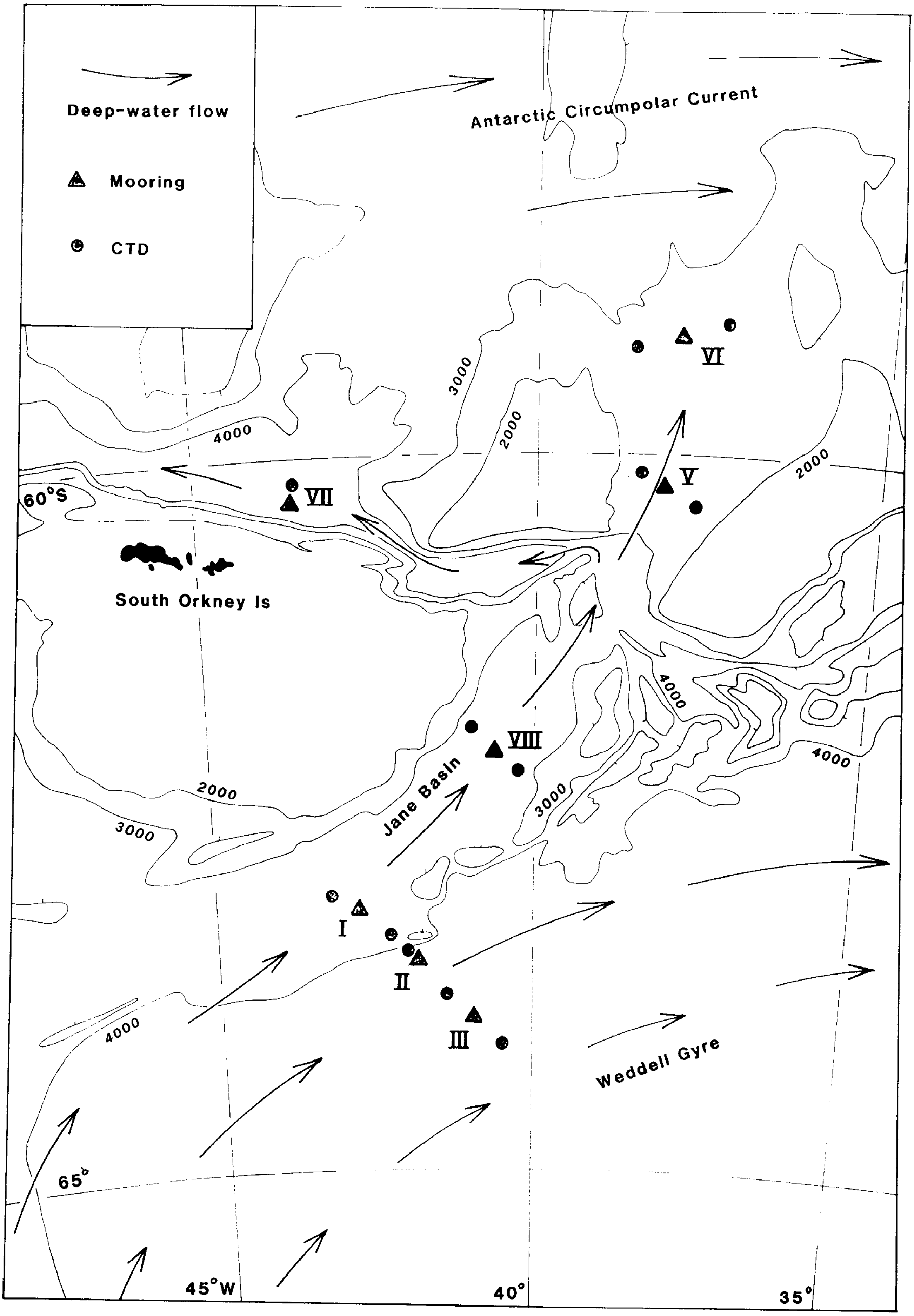
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1. INTRODUCTION

The scientific objectives of JB10/3 were the recovery of six current meter moorings from the northern Weddell and southern Scotia Sea, the deployment of three new moorings, and measurement of the density field using deep CTD casts. This oceanographic work forms part of an investigation of Antarctic Bottom Water and its effect on deep-sea sedimentation (Project B6111, Southern Ocean Palaeo-oceanography and Palaeoclimate). The aims are i) to document the relationship between present-day currents and sediment transport and deposition, ii) to study the coupling between newly-formed Weddell Sea Bottom Water, older Antarctic Bottom Water and the Antarctic Circumpolar Current.

Of the six long-term current meter moorings, three (I, II, III; fig 1 and track chart) had been deployed from RRS Discovery in February 1988 and scheduled for retrieval the following year. However, in February 1989 pack ice prevented access to the mooring area by RRS Charles Darwin: the old moorings stayed down and three new ones were deployed further north (V, VI, and VII). Moorings I, II and III were intended to measure the flow of bottom water along the northern margin of the Weddell basin (II and III) and in southernmost Jane Basin (I). The new moorings monitored current flow north from Jane Basin (V), west from Jane Basin (VII) and near the Weddell-Scotia Confluence (VI). We had not intended to lay moorings in the Scotia Sea without first measuring the flow at an intermediate site in Jane Basin. The moorings deployed in March 1990 were therefore at sites I and III (continuing long-term observations) and VIII (fig.1). Piston cores at each of these three sites show they are areas of rapid (12-25 m/Ma) Quaternary sedimentation, and we hope to use the current meter data to interpret downcore textural changes.

During the cruise all the six moorings were successfully recovered, three new moorings were deployed and 19 out of 20 planned CTD stations were occupied. Underway XBT measurements were made and surface water samples taken. Six additional CTD casts were made near South Georgia and the cruise finished one day ahead of schedule, with the only equipment loss being one flooded current meter. It is intended that moorings I, III and VIII will record data for two years and be recovered in the 1991-2 season.

Fig. 1 Positions of current meter moorings in relation to deep-water flow. See also track chart at end of report.

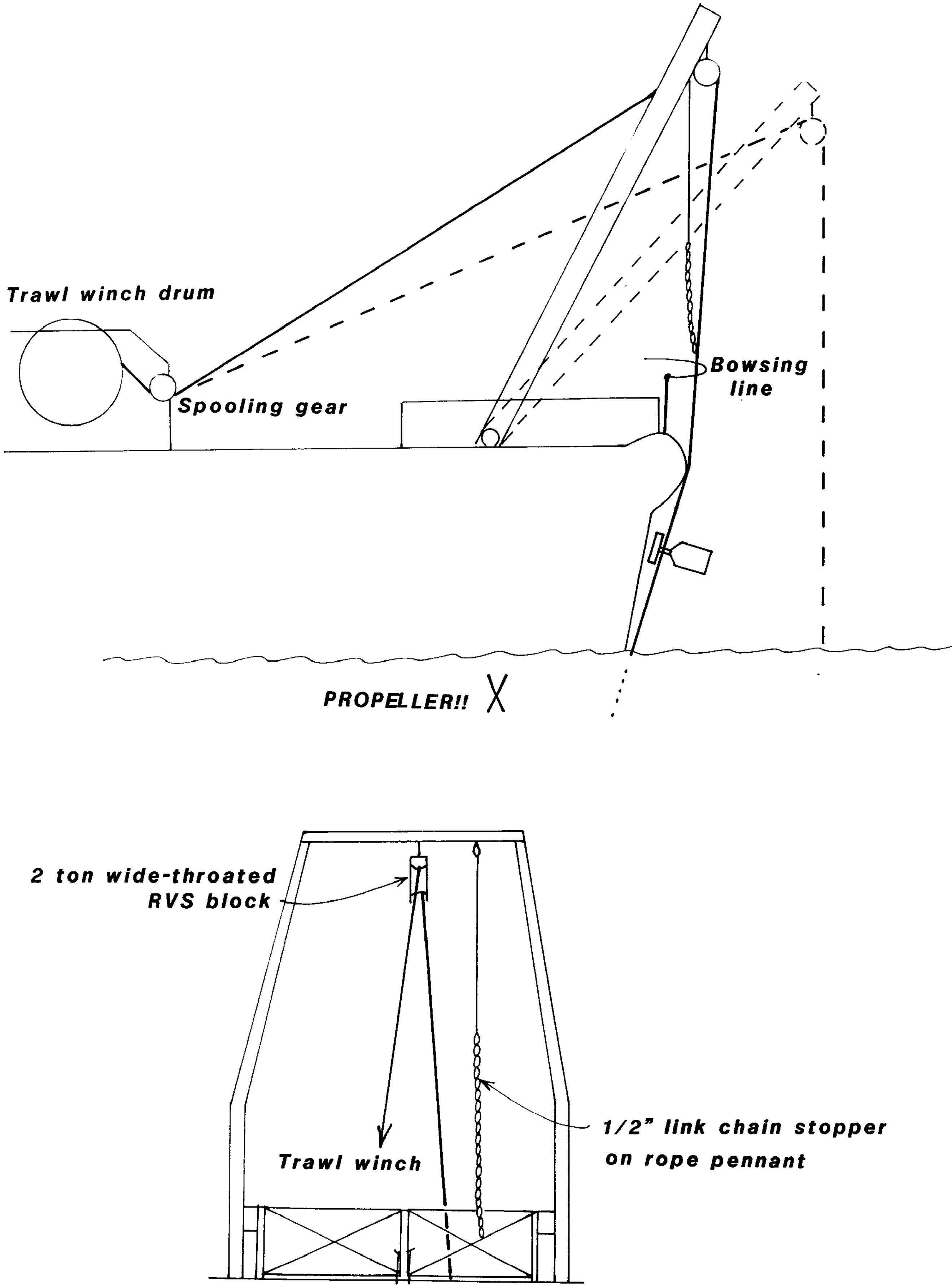


Fig. 2. Recovery and deployment of moorings using stern A-frame. Above, view from port side; below, view looking aft.

2. SCIENTIFIC NARRATIVE

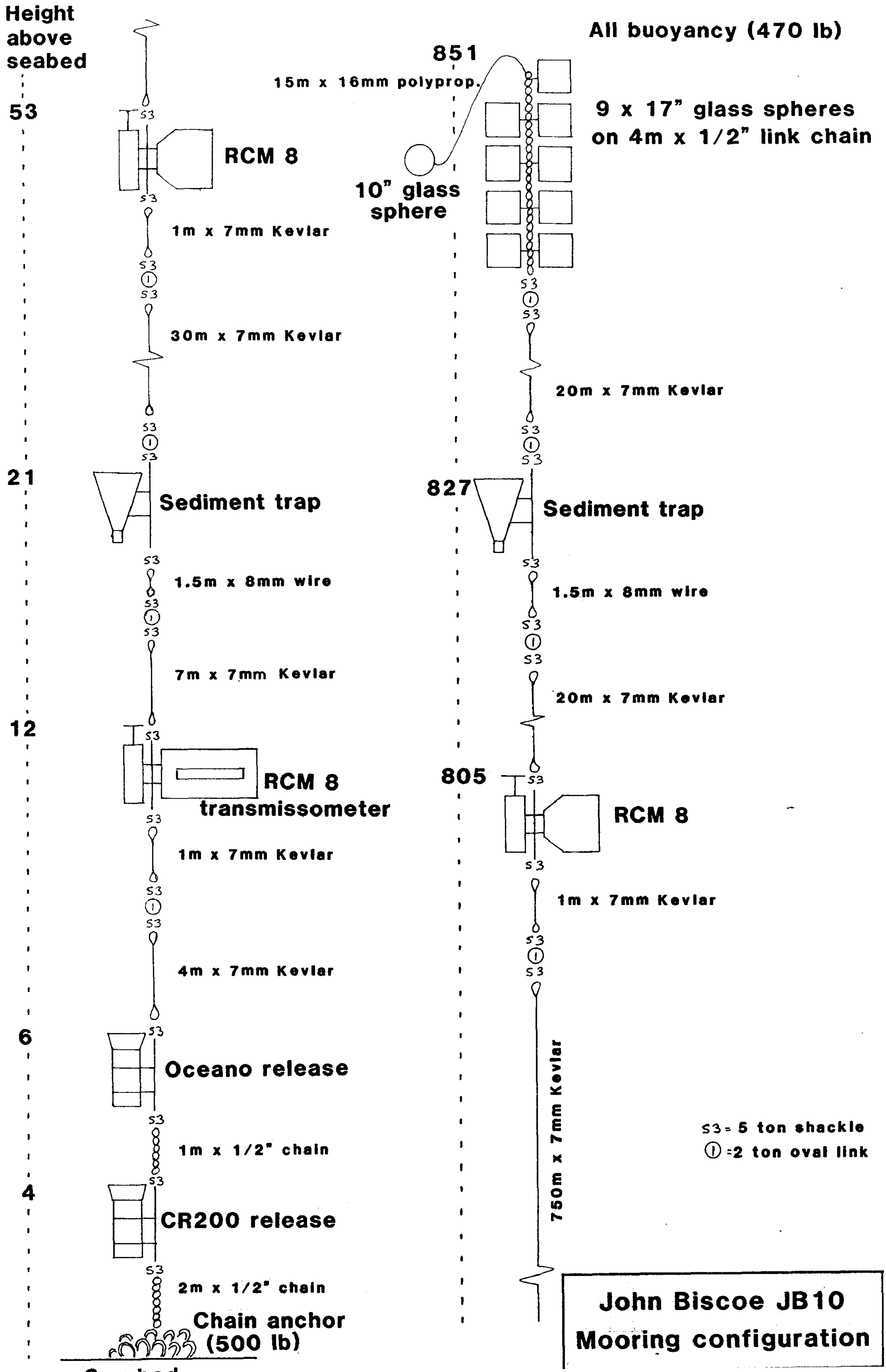
RRS John Biscoe left Port Stanley, Falkland Islands, at 1400 on February 28th, 1990. Four of the scientific party had boarded less than half an hour before (their flight having been diverted back to Ascension Island the previous evening): the rest of the scientists had stayed on board after Leg 2 of the Offshore Biology Programme. All the airfreight and seafreight had arrived and we were able to make a start on unpacking while the ship bunkered in Berkeley Sound.

During the $2\frac{1}{2}$ day passage to Signy Island the laboratories were set up for oceanographic work and sections of the moorings were assembled. The steel brackets for the sediment traps had been inadvertently left behind in Port Stanley, so the ship's engineers made four new ones. The Ocean Logger and Navigation Logger were run continuously during the passage. The Navigation Logger was used for the whole cruise with DR positions at 10-minute intervals: the Ocean Logger was turned off while the ship was on station.

The scheduled three-day visit to Signy was reduced to one afternoon because the refuelling which was to have taken place had already been done earlier in the season. Accordingly, after an enjoyable and interesting visit to the base, the ship left Signy anchorage at 1800 on March 3rd (Day 062). The Precision Echo Sounder (PES) fish was deployed from the starboard cargo boom: it towed at 5 m depth, which was considered rather shallow but was in practice satisfactory. $2\frac{1}{2}$ tons of deck cargo had been unloaded at Signy so the after deck was now clear for mooring work. During the night we steamed along the south coast of Laurie I. and NE towards the first mooring site.

The first CTD station (032) was a deep (5200 m) site some 10 miles N of mooring VII. A 10 kHz pinger was attached below the CTD on a wire bridle, the aim being to lower the CTD to very near the bottom while monitoring the pinger-bottom echo separation on the PES. However, in very deep water and with a soft bottom no return echo was observed, and even the direct echo was faint. The CTD was therefore lowered to within 20 m of the bottom as measured by the pressure sensor on the CTD itself. We then searched for, located and recovered mooring VII, the whole process taking $4\frac{1}{2}$ hours (Section 3.3a, Table 2). At these first stations the moorings were recovered aft, using the stern A-frame with a block in the centre, a stopping-off line on the port side of the A-frame, and winding the mooring line on to the trawl winch (fig.2). The recovery was followed by a CTD (033) approximately on the mooring site and this finished at 2230. It was not possible to do the CTD first because daylight was necessary for the recovery operation. The CTD 3 miles south of the mooring was not attempted because of the proximity of the site to a very steep submarine slope and the difficulty in seeing a pinger-bottom echo in deep water.

On the passage south to the group of moorings in the northern Weddell Sea, 8 XBT casts were made across the South Orkney shelf and slope to investigate mixing of the well-stratified open-ocean water masses over submarine topography. On arrival at the next CTD site the



John Biscoe JB10
Mooring configuration

wind was 30-35 knots NW and the barometer was falling, so instead of a CTD we did a wire test on two of the acoustic releases destined for the new moorings. This was successful, and the wind moderated enough to permit CTD 034 to go ahead. This time, and on nearly all subsequent casts, a good pinger-bottom echo was observed and the CTD lowered to within 10-15 m of the sea bed.

The ship then headed for mooring I but the site was occupied by a pair of icebergs. We went on to the next CTD south (035), did that and another wire test, and returned to the now clear mooring site in the forenoon of March 6th. Mooring I was recovered in 3 hours and we stayed on station to do CTD 036 while the new mooring was made ready (fig. 3). Deploying it was a traumatic experience. Darkness fell and the wind gradually increased to gale-force WSW. There were several delays caused by the mooring line jumping off the sheave on the A-frame and getting stuck down the side of the block. It was freed by pulling with a rope or boathook from above. As the wind and sea got up the ship became more difficult to control using the bowthrust, and when the main engines were put slow ahead the mooring line led so far aft that we could not stop off and attach the current meters. Near the end of the deployment, when the upper sediment trap was in the water and only the floats remained, the kevlar warp became irretrievably jammed in the block and started to chafe. This potentially disastrous situation was saved by the Mate who put a West Country stopper on the outboard part of the warp: the weight of the mooring was then lifted on the aft crane until the line could be cut above the stopping and tied off in the normal way. The kevlar was removed from the block by heaving with the trawl winch until the line broke. Continuing the deployment was evidently a lesser evil than trying to recover the gear, and the buoy was finally cut free at 2245, the deployment having taken 4½ hours.

We then steamed to the next CTD site and spent 15 hours waiting on weather. During this time a meeting was held to discuss mooring deployments. The Master and Mate said they would have no more vertical wires over the stern, as this ship has an unprotected propellor, the bow thrust is not very powerful and the bridge cannot see a wire on the stern A-frame. They were however, prepared to consider mooring work from the foredeck using the starboard cargo boom. Re-arrangement of the foredeck would be done in daylight, so we did two CTDs overnight (037 and 038). In the morning the PES fish was moved to the port side and the rig shown in fig.4 put together on the starboard side. A more suitable headblock had been found for the outboard end of the derrick. We were then able to locate and recover mooring II with a good deal less grief, the wire angle being much better controlled this way.

Fig. 3 Sketch of current meter/transmissometer/sediment trap moorings deployed on JB10, Leg 3. Not to scale.

(1) 28mm polyprop. runner on to windlass
Make up on bulwark cleat

(2) Derrick headblock: 2 ton wide throated
block, wooden sheave, ex RMT fish boom

(3) 1/2" chain stopper on rope pennant

(4) Extension piece

(5) Tailblock on downhaul from bulwark to keep line in sheave of headblock

(6) Heel block: 3 ton wide/deep throat Gilsen block

(7) Snatch block tail for spooling

(8) 750m x 7mm Kevlar warp run on to barrel over 50m x 12mm wire runner

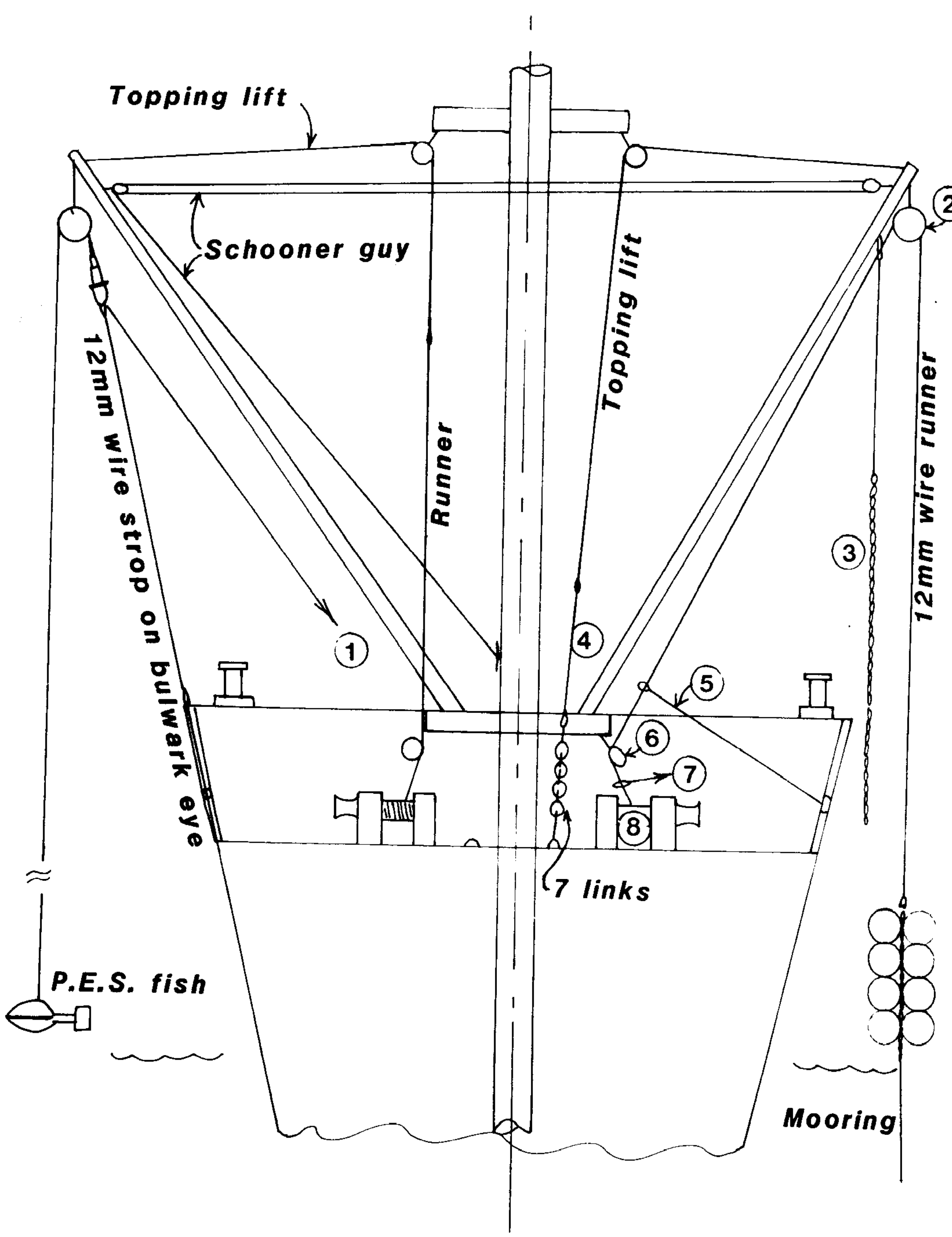


Fig. 4. Rig of forward derricks for PES fish and recovery and

Two more CTDs followed, 039 on the way to and 040 on the site of mooring III. Having safely recovered two moorings from the foredeck, including the bulky floats on both and the heavy WHOI sediment trap on III, it was decided the rig could also be used for deployment. While the new mooring was being prepared we occupied CTD 041, the southernmost site at 64 deg.S. A problem with satellite fixes delayed deployment of mooring III and left the final position 3 miles west of the waypoint, but the deployment went smoothly. Feeling a good deal better about moorings we headed north towards Jane Basin.

From mooring III north across the Scotia Sea and the Antarctic Convergence, XBTs were launched at approx. 30 mile intervals. The combined CTD and XBT data constitutes a N-S transect spanning 13° of latitude (see track chart).

Arriving at CTD 042 in the morning of March 10th, we found the weather marginal for CTDs so did a wire test instead: after a few hours the sea moderated and we proceeded with the CTD. When the instrument was at 1500 m on the way down the logging program crashed and we had to start the cast again. By the time we reached the next site it was dark so we did CTDs 043 and 044 overnight and deployed mooring VIII the next morning. The CTD cable had to be re-terminated at the inboard end between stations 043 and 044 because a slight leak was giving occasional spurious values for salinity and density. Mooring VIII took longer than usual to deploy because the kevlar warp again tried to escape from the headblock several times.

On the way to the next group of sites we were delayed by thick fog and growlers. CTD 045 was completed in the morning of March 12th, and we got CTD 046 in that afternoon before the weather became too rough to work on the foredeck. It blew force 8-9 with snow showers for about 36 hours, WSW backing S, while the ship steamed slowly to and fro dodging icebergs. In the morning of March 14th the gale abated, we did CTD 047 then returned to mooring V, located and recovered it successfully. We then steamed at full spped north to mooring VI and were just able to recover it in daylight the same evening. The last three CTDs took about 2½ hours each and with the recovery of the PES fish at noon on March 15th the geophysics programme was completed.

We had been asked, if there were any spare time at the end of the cruise, to undertake part of a CTD transect on behalf of Barry Heywood (BAS) and Neil Wells (Southampton Univ.). In the original ship's itinerary there was no spare time, but because we had left Signy 2½ days early and had made up time during the mooring work (despite the bad weather) we were able to occupy six CTD stations SW of Bird Island during March 16th-17th. The first four were to 1000 m in deep water and the other two on the continental shelf (Table 5). The evening of March 16th was the only really calm weather we had on the whole cruise.

The ship arrived off Bird I. in the morning of March 17th (Day 076), one day ahead of schedule. After launching the boats she moved round to anchor in Elsehul until 1400 when the transfer of personnel and cargo was completed. We used the last few XBTs in crossing the Polar Front Zone and arrived in Montevideo at 0800 on March 23rd.

3. EQUIPMENT REPORT

3.1. Navigation

Satellite fixes were obtained using a Magnavox system, and supplemented by radar fixes when near land. The satellite data were logged by the program NAVRUN11, which was set up to print dead-reckoning positions every 10 minutes as well as the fixes. As used on the Biscoe this arrangement had two shortcomings:

a) DR positions were not printed out every 10 minutes 00:10, 00:20, 00:30, 00:40, etc. The arrival of each fix caused the print interval to move on by one or two minutes. Between fixes the print interval usually (not always) stayed at 10 minutes. See table 1.

b) Much more serious was the lack of accurate log input to the Magnavox. The ship's log, which had allegedly been calibrated before leaving Grimsby, under-read forward speed by approximately 20% and the port/starboard log was not working at all. A value for speed was input manually by the Navigating Officers: this was an informed estimate based on engine revs. This worked reasonably well on passage but was unreliable while manoeuvering at slow speed (e.g while searching for a mooring) or while hove-to. We have found on previous cruises that ships often make ½ knot fore-and-aft or athwartships while hove-to. The Magnavox uses the ship's own speed to calculate a position, so if it receives incorrect log input the calculated position will obviously be in error.

3.2. Mufax Precision Echo Sounder

The transducer fish was deployed on day 062 and the PES recorder switched on. The recorder performed well until the 100 m depth marks showed a double line; this was rectified by replacing circuit board 7 (depth mark dividers and decoders).

The next fault to occur was the loss of transmission signal on day 063; this was corrected by replacing board eight (transmission gate generator).

The last fault encountered was the failure of the 30 rpm Helix Speed on day 067, therefore the 1500 m scale was lost. The PES was examined and the fault thought to be in the ledex controlled switches. It was decided not to stop the PES for repair as this would have held up the science and that the 750 m scale was adequate for cruise requirements. This fault remained unrectified.

3.3. Moorings

a) Recovery procedure: steam to within 1 mile of waypoint, reduce speed to 5 kts, interrogate lower release using channel 1 and watch for pinger trace on PES. If no response, interrogate upper release. Switch to channel 2 (double ping) and *continue on same course until just past position of closest approach. Alter course 90° to starboard: if again approaching mooring, repeat from *. If not, alter course 180° and repeat from *. When closest approach achieved, activate release. Surfacing time may be predicted, measuring ascent rate (typically 65 m/min) and knowing water depth. When mooring is on surface, search may be continued using PES until the floats are sighted. The stray line is then grappled and the mooring hauled inboard, stopping off to remove each instrument.

b) Deck handling: the lack of a suitable deep-throated block for the A-frame or cargo derrick was a severe problem and could have resulted in serious injury to personnel and loss of equipment. That it did not was a result of luck as well as good seamanship. While working moorings on the after deck, it would have been useful to have a TV surveillance camera with a monitor on the bridge, so that whoever was driving the ship could see the wire angle.

c) Acoustic releases: during recoveries, all the IOS CR200 releases worked correctly and we were able to detect the signal using the PES at up to 2 miles range. Up to 6 command pulses were required to fire the release pyros, but in each case release was achieved within 3 minutes of starting the commands. Moorings V, VI and VII were recovered with live pyros because each had two CR200 releases of which only the lower one had been fired. Upon recovery the live pyros were immediately disarmed. None of the release batteries had decreased in voltage significantly during deployment.

Before deployment three separate wire tests were undertaken; in each, one IOS CR200 command release and one Oceano RT361 release transponder were tested at approximately 2500 m. Some difficulty was experienced achieving the correct working depth, due to the lack of a line-out meter on the forward hydro winch. The depth was estimated by measuring the descent rate, using the direct return from the CR200 pinger. All CR200 tests were successful with both puffers firing. Both channels 1 and 2 proved not to have drifted from the auxiliary tests performed at IOS DL. The Oceano instruments released on command, but the release transponders failed to give an accurate range. This fault was thought to result from the small overside transducer being too near the ship's hull and not vertical. For the recovery a larger tadpole transducer will be used.

d) Current meters: the data return was only about 40% (Table 3) because of the near-total failure of the solid-state memories on the RCM-8s and problems with the tapes on the RCM-5s. One meter on mooring VII was flooded.

The lack of data return on the RCM-8s is thought to result from battery failure at low temperatures. This is a preliminary conclusion, and further investigation of the problem will be undertaken when the instruments are returned to the Ocean Science Group at RVS. The reason for the complete or partial failure of 7 out of 12 RCM-5s is thought to be a malfunction of the encoder mechanism, due to the low temperatures at which they were deployed. It should be noted that all the meters on moorings I, II and III were serviced at sea before re-deployment and the data return on these was over 60%.

e) Sediment traps: A WHOI Parflux Mark IV sediment trap was recovered on mooring III. Four bottles had been filled during the 2-year deployment period: from the schedule data retrieved from the controller (Table 4) it appears that the first five (0 to 4) events proceeded correctly but that nothing further happened. Bottles 1 and 4 were less than half full, bottles 2 and 3 were completely full.

All the simple funnel-type traps collected sediment, mostly organic in appearance but including flakes of rust from the mooring wire and shackles. By far the most sediment was in the traps on mooring VII, the furthest north.

The sediment trap material was stored frozen for subsequent analysis. The WHOI trap was not re-deployed as it is due for servicing.

3.4. CTD and related equipment

The CTD system worked, within its operational limitations, satisfactorily during the cruise: that is, data were collected at all of the stations. It was, however, not without some difficulty on the part of the operators.

a) Hardware

To those accustomed to RVS ships it seems that the deck handling of the CTD could hardly be made more awkward. Every time the unit is trundled along the starboard side-deck there is risk of damage to the water bottles. Lifting the unit over the foot-high sill into the water-bottle annexe is not a particularly safe procedure either for personnel or equipment when the ship is moving about. On a more positive note the aft hydro winch and A-frame worked well at all times. During deep CTD casts there is a noise problem with the hydro winch (particularly for residents of the starboard alleyway) and it may be that the hydraulics require some maintenance.

Apart from one or two failures, all twelve 2.5 l water bottles fired on every drop. The CTD was fitted with pressure, temperature and conductivity sensors. Because the instrument does not have a sturdy frame we could not attach additional sensors such as a transmissometer, which would have been useful. Also, the pinger used to measure height above bottom had to be hung below the CTD on a wire bridle.

The 10 kHz pinger worked all the time except for battery failure near the end of one cast. The batteries were replaced.

It was noticed that with a pinger-bottom separation of 10-15 m (hence pressure sensor at least 15 m off bottom) the depth as measured by CTD pressure was some $1\frac{1}{2}$% greater than the corrected depth measured using both the bridge echo sounder and the lab. PES i.e the CTD appeared to be 50 m below the seabed on a 3000 m cast. Clearly this was not the case. Possible reasons are i) malfunction of both the bridge and lab. echo sounders, ii) wrong depth correction in Matthews tables iii) pressure sensor needs re-calibrating. We consider iii) most likely.

A problem was encountered when the Neil Brown deck unit began to give erroneous values for the CTD data. The fault was traced to water leaking into the electrical/mechanical termination at the CTD. The termination was remade and the problem cured.

Both temperature and salinity data remain uncalibrated at present. There were some reversing thermometers on board which had been intended for use at Signy, but they did not appear to be in very good condition and no calibration certificates were available, so they were not used. Many water samples were taken for salinity measurements, but the on-board Autosal proved to be unusable in anything but flat calm conditions. Engine vibration may also have contributed to the problem of being unable to obtain stable readings. Salinity calibrations will therefore be done back at Cambridge.

b) Software.

The CTD logging program is very unsatisfactory and inflexible. There is no graphical display of the data during a drop, but it is vital to have a real-time display of temperature and salinity if water samples are to be taken intelligently. Nearly all the stations occupied during this cruise were repeats, so sample depths had been determined during previous cruises: but going in to a new area one would be working almost blind. It is quite remarkable that a display of 5 m-averaged data as numbers on the screen has been considered adequate for so long.

The program used for data reduction is very slow, taking about 5 minutes to work up 200 m worth of data. There is insufficient space on the disk to work up more than about 2800 m worth of data, and some casts on this cruise went to more than 5000 m with particular interest in the lowest 1000 m. The program does not allow one to reduce data starting at an intermediate depth. Hence no plots of the deep CTD casts could be produced during the cruise.

Particular problems included:

- occasional "hang-up" of the logging computer during the descent phase, necessitating the drop to be aborted. The program could not be re-started at an intermediate depth so the CTD had to be brought to the surface and the cast re-started.

- occasional "hang-up" when the ascent stage was being initialised. This meant that the bottles had to be fired manually.

If either of these happened while the processor was writing to tape, a new magnetic tape had to be installed and initialised before we could proceed.

There was an apparent failure of the CTD printers, but it was discovered that a particular command was required after resetting. No hardware failures occurred with the logger during the cruise.

3.5. Expendable Bathythermographs (XBTs)

36 XBTs (type T-7) were available for this cruise. Six probes failed for reasons such as the wire breaking or the probe hitting the side of the ship, but the rest gave good temperature data down to about 750 m.

Two XBT transects were obtained (see track chart and table 6):

a) across the South Orkney microcontinent, to investigate mixing over the shelf and slope.

b) from mooring III through moorings VIII, V and VI to Bird I. and a further 250 miles to the NW. This transect links the deep CTD casts and crosses the northern margin of the Weddell Gyre, the Weddell-Scotia confluence and the Antarctic Convergence. Stations are about 1 every 30 min of latitude.

The data were downloaded from tape cartridge to disk, and plotted on board.

3.6. Water Sampling

(i) Surface water samples of 2 l were taken from the ship's laboratory seawater supply and filtered through a 0.4 μ Nucleopore filter using a vacuum pump. Sample locations are shown in table 7. In many cases the filter clogged before the whole sample had passed through. Filtering was stopped when the flow rate became unacceptably slow (less than 5 ml/min, approx.). These samples will be used in phytoplankton studies for comparison with core material.

(ii) Water samples were also obtained during the deep CTD casts 032 to 050. At all these stations bottles were fired at 10 m, 50 m, 200 m and 800 m above the bottom and 2 l of each sample filtered for suspended particulate matter (i.e nephels). At the CTDs on the mooring sites bottles were also fired at 400 m, 600 m and 1000 m off the bottom and at every 500 m to 1500 m down from the surface. 50 ml of water from each of these depths was retained for oxygen isotope analysis. (Table 8).

4. ADDITIONAL CHEMICAL AND BIOLOGICAL STUDIES

4.1. Ecology of heterotrophic protozoans in Antarctic Waters. (RJGL)

Information on the ecological role of protozoans in antarctic waters is lacking. Few quantitative studies of population standing stocks have been undertaken and no experimental data on grazing and production rates are available. Research activities during this cruise have therefore focused on the estimation of protozoan (ciliate and flagellate) standing stocks and production in the Weddell Sea, following on from and allowing comparison with similar studies undertaken in South Georgia waters during OBP.

Water samples were taken at 6 depths throughout the mixed layer from surface waters at stations 034, 037, 040 and 050. Samples were preserved with Lugol's iodine (for ciliate standing stocks). Bouin's fluid (for ciliate taxonomy), formaldehyde (for ciliate cell division estimates) and glutaraldehyde (for estimates of bacterial and flagellate abundance). Glutaraldehyde-preserved samples were stained with the fluorochrome DAPI, concentrated onto 0.2 μm filters and slides prepared. All samples were then stored cool or frozen for post-cruise analysis. Protozoan production rates were measured experimentally at station 040 by fractionation assay. This assay enables field rates to be compared with estimates derived using laboratory derived growth constants. Enrichment cultures were also prepared from water samples collected in the vicinity of Signy Island. Preliminary analysis revealed protozoan abundances similar to those observed in waters off South Georgia, however, further comparisons of population standing stocks and production from the two localities awaits full analysis on return to the UK.

4.2 Methane concentration and bacterial oxidation in the Weddell Sea (VL)

Methane concentration: the concentration of methane at various sites was examined at 6-8 depths throughout the water column for comparison with the concentrations found on JB10 leg II. Although time constraints did not permit such extensive study as that carried out during legII, several interesting profiles were obtained, and further calculations on these profiles may reveal similar trends to the first study. The methane was measured using gas chromatograph techniques. Due to the failure of the equipment, methane from the last three CTD sites could not be measured.

Total Bacterial activity: the bacterial activity throughout the water column was calculated using 3H-Thymidine uptake analysis. At each of the sites where methane concentration was calculated, samples from about 5 depths were taken for bacterial activity calculations. The final analysis of these data will be performed on return to the UK.

Methane Oxidation: Methane oxidation by bacteria, methanotrophs, has also been investigated in most of the above sites, and at several depths. Again, this work will be analysed on return to UK.

Methane enrichment of Methantrophs: at several sites, seawater from different depths was incubated with methane to attempt to obtain cultures of methane oxidizing bacteria. As yet, these show no growth, but they will remain incubating until return to UK.

Freshwater samples: whilst on Signy, samples were taken from Sombre Lake water to provide a comparison with the marine environment. Several similar experiments have already been carried out at Sombre, by BAS scientists. All the above experiments were carried out on water from Sombre, with the addition of the examination of methane production from sediment from Sombre.

Additional work: finally, several litres of surface seawater from the area have been collected for molecular biological studies on return to the UK.

4.3. Investigation of Lipid Partitioning and Utilisation in Antarctic Copepods. (SVW)

Copepods were sampled in the seas around South Georgia during JB10 legs I and II. Those obtained during leg III will provide a valuable comparison, being later season and higher latitude Antarctic specimens. Little is known of the winter survival strategies of copepods, but their lipid stores are known to provide both a vital food reserve and buoyancy aid. This study permitted sampling for investigations of the pre-winter lipid status of copepods in true and sub Antarctic conditions.

Methods: Sampling employed a 200 μ, 1 m diameter zooplankton net (Z net) with solid cod-end, hauled vertically through the water column by a winch at 7 m/min. Eleven hauls were made, 8 from 150 m, 2 from 600 m and 1 from 50 m. The net was deployed opportunistically during mooring retrieval and deployment and while waiting on weather. A sample of copepods from each was frozen immediately following species identification and aging. Others were kept alive, either to establish one of 3 starvation experiments, for for live return to the UK. Several starvation studies have also been continued from leg II; these involve maintaining copepods in filtered seawater at a constant temperature and sampling at intervals. Surplus organisms from hauls were preserved in formalin for analysis at BAS.

Results: Three species of calanoid copepod were dominant in the Weddell Sea and these were mainly caught at (Copepodite) stage V, although numerous earlier stage copepodites were also identified. More northerly samples contained a fourth calanoid species which was rare in the Weddell Sea. All lipid analyses will be performed at BAS HQ.

Conclusions: Leg III has provided an exciting opportunity to obtain samples of copepods preparing for winter diapause, the true value of which can only be appreciated following analysis of the lipids on return to the UK. The option to extend Leg III starvation experiments and initiate new ones with higher Antarctic species collected later in the season has also been valuable. In addition, the development and maintenance of 2 recirculating tank systems containing respectively copepods and krill has been a project during the Leg III which will provide unique live specimens on return to the UK.

5. CRUISE STATISTICS

Total cruise time from leaving the Falklands to arriving in Montevideo	22.4 days
Passages from the Falklands to Signy and Bird I. to Montevideo	8.4 days
Calls at Signy and Bird I.	0.6 days
Total scientific time	13.4 days

Moorings	1.3 days
Wire tests and re-rigging	0.7 days
CTD's	3.0 days
Steaming between stations	6.1 days
Waiting on weather	2.3 days

	13.4 days

6. ACKNOWLEDGEMENTS

Cruise JB10/3 was a great success, all the objectives being fulfilled with minimal equipment damage and with a day in hand. This resulted from the skill and professionalism of the ship's company listed below, their willingness to help particularly appreciated at the end of a long season. Thanks to Jerry the Mate who supervised the mooring recoveries and deployments on deck, to Steve and George who went aloft on the A-frame in horrible weather to disentangle the mooring line, to Dave the Chief who made the sediment trap brackets and to Alan who maintained the lab. seawater pump.

Clive and Darrel did a fine job on the moorings, Clive already having undertaken most of the scientific logistics work. Carolyn and Mark kept the CTD going despite its idiosyncrasies. Thanks also to the OBP scientists and FIDS Ray, Roni, Sally, Barry, Colin and Rory who helped out with the watchkeeping and deck work as well as pursuing their own studies.

Carol J. Pudsey

20/4/90

SHIP'S COMPANY

Officers

Master	E M Phelps	Chief Eng.	D Cutting
Chief Off.	M J S Burgan	2nd Eng.	D J Allan
2nd Off.	W J Pearn	3rd Eng.	C J Johnson
3rd Off.	J H Harper	4th Eng.	M Inch
Radio Off.	C A Waddicor	Elec. Eng.	A Jones
Cat. Off.	K R Olley		

Crew

Bosun	J W Summers	M'man	C A Chard
B. Mate	G M Stewart	M'man	D Summers
Launch	A Gill	M'man	C R Baker
SG1	M Brookes	M'man	J G Sutherland
SG1	J H Williams	Ch. Cook	P D Lucas
SG1	B J Lewis	2nd Cook	S Hewitt
SG2	R J Mortimer	Steward	E J Butler
SG2	S J Sheppard	Steward	S W Tucker
JS	G C Sate	Steward	M A Hanley
		Steward	M Weirs

Supernumaries

	Scientists		FIDS
PSO	C J Pudsey	Doctor	R. O'Conor
	M E Barber		B W Clark
	C J Symon	SPRI	C M Harris
	M O Preston		S P Rodwell
RVS	C Washington		M R Jones
RVS	D A Phillips		
	R J G Leakey		
	V Lees		
	S V Worby		

Table 1. Example of nav-logger printout.

	Elapsed time		Long	GMT	date	WP range and bearing		speed	course	set		p/s speed	
FIX:		58 0.84S	39 6.01W	20 44 42	15/ 3/90					0.1	304		
DRT:	0 12	57 58.65S	39 7.41W	20 57 0	15/ 3/90	127.9	339.7	11.0	340.9	0.3	332.1	0.0S	
DRT:	0 22	57 56.87S	39 8.56W	21 7 0	15/ 3/90	126.0	339.6	11.0	341.9	0.3	332.1	0.0S	DR every 10 min on 7 min
DRT:	0 32	57 55.10S	39 9.69W	21 17 0	15/ 3/90	124.1	339.6	11.0	341.9	0.3	332.1	0.0S	
FIX:		57 55.93S	39 9.12W	21 12 42	15/ 3/90					0.1	148		Fix
DRT:	0 15	57 53.22S	39 10.85W	21 28 0	15/ 3/90	122.1	339.6	11.0	339.9	0.3	332.8	0.0S	
DRT:	0 25	57 51.45S	39 11.99W	21 38 0	15/ 3/90	120.3	339.5	11.0	341.6	0.3	332.8	0.0S	DR every 10 min on 8 min
DRT:	0 35	57 49.68S	39 13.12W	21 48 0	15/ 3/90	118.4	339.5	11.0	342.1	0.3	332.8	0.0S	
FIX:		57 50.15S	39 13.40W	21 44 57	15/ 3/90					0.3	282		Fix
DRT:	0 14	57 47.65S	39 15.07W	21 59 0	15/ 3/90	116.1	339.7	11.0	340.8	0.4	312.8	0.0S	
DRT:	0 24	57 45.87S	39 16.25W	22 9 0	15/ 3/90	114.2	339.6	11.0	341.8	0.4	312.8	0.0S	
FIX:		57 45.56S	39 16.32W	22 10 7	15/ 3/90					0.1	13		Fix
DRT:	0 9	57 44.12S	39 17.28W	22 20 0	15/ 3/90	112.4	339.6	7.5	341.4	0.4	320.2	0.0S	
DRT:	0 19	57 42.88S	39 18.11W	22 30 0	15/ 3/90	111.1	339.6	7.5	340.6	0.4	320.2	0.0S	Jump forward 1 min
DRT:	0 30	57 41.52S	39 19.01W	22 41 0	15/ 3/90	109.6	339.6	7.5	341.1	0.4	320.2	0.0S	
FIX:		57 42.01S	39 18.72W	22 38 7	15/ 3/90					0.1	168		Fix
DRT:	0 13	57 40.34S	39 19.85W	22 52 0	15/ 3/90	108.4	339.6	7.0	341.3	0.4	315.1	0.0S	
DRT:	0 23	57 39.20S	39 20.63W	23 2 0	15/ 3/90	107.1	339.6	7.0	341.4	0.4	315.1	0.0S	
DRT:	0 33	57 38.05S	39 21.40W	23 12 0	15/ 3/90	105.9	339.6	7.0	341.8	0.4	315.1	0.0S	Jump forward 1 min
DRT:	0 44	57 36.79S	39 22.25W	23 23 0	15/ 3/90	104.6	339.6	7.0	341.4	0.4	315.1	0.0S	
DRT:	0 54	57 35.64S	39 23.02W	23 33 0	15/ 3/90	103.4	339.5	7.0	340.6	0.4	315.1	0.0S	
FIX:		57 35.75S	39 22.84W	23 33 32	15/ 3/90					0.2	145		Fix
DRT:	0 10	57 34.57S	39 23.63W	23 44 0	15/ 3/90	102.2	339.5	7.0	340.6	0.3	311.2	0.0S	
DRT:	0 20	57 33.44S	39 24.38W	23 54 0	15/ 3/90	101.0	339.5	7.0	341.9	0.3	311.2	0.0S	Jump forward 1 min
DRT:	0 31	57 32.19S	39 25.21W	0 5 0	16/ 3/90	99.7	339.5	7.0	340.6	0.3	311.2	0.0S	
DRT:	0 41	57 31.06S	39 25.96W	0 15 0	16/ 3/90	98.5	339.5	7.0	341.4	0.3	311.2	0.0S	DR every 10 min on 5 min
DRT:	0 51	57 29.93S	39 26.70W	0 25 0	16/ 3/90	97.3	339.5	7.0	341.8	0.3	311.2	0.0S	

TABLE 2 Moorings

Recovery of Rig VII

	1538/063/90	Start search		Fixes	
	1600	Hove to on station	1622	60°19·18'S	43°36·44'W
	1603	Release commands	1700	60°19·22'S	43°36·87'W
	1604	Released	1717	60°19·29'S	43°36·64'W
	1732	On surface	1808	60°18·70'S	43°35·30'W
4½hrs	1805	Buoys sighted	1838	60°18·77'S	43°35·42'W
	1820	Grappled			
	2000	All inboard			

Recovery of Rig I

	1344/065/90	Start search		Fixes	
	1407	Hove to on station	1355	63°10·59'S	42°45·20'W
	1410	Release commands	1508	63°10·82'S	42°42·35'W
	1413	Released	1547	63°10·44'S	42°42·62'W
3½hrs	1501	On surface			
	1514	Buoys sighted			
	1535	Grappled			
	1710	All inboard			

Re-deployment of Rig I

			Fixes	
2110/066/90	On station	2111	63°11·33'S	42°40·73'W
		2132	63°11·47'S	42°40·82'W
0146/067	Mooring cut loose	2159	63°11·36'S	42°40·97'W
0229	On bottom	2221	63°11·16'S	42°42·29'W
		2256	63°11·49'S	42°42·34'W
		2346	63°10·70'S	42°39·94'W
		0006	63°10·41'S	42°40·37'W
		0109	63°09·36'S	42°39·67'W
		0132	63°09·16'S	42°41·07'W
		0151	63°08·90'S	42°41·22'W
		0224	63°08·80'S	42°41·60'W

Recovery of Rig II

	1625/067/90	Start search		Fixes	
	1708	Hove to, release commands	1700	63°30·78'S	41°45·16'W
3hrs	1712	Released	1726	63°31·38'S	41°43·60'W
	1813	On surface	1802	63°31·31'S	41°43·15'W
	1818	Buoys sighted	1853	63°30·88'S	41°44·36'W
	1925	All inboard	1912	63°30·89'S	41°43·83'W

Continued.........

Table 2 - continued

Recovery of Rig III

	0830/068/90	Start search		Fixes	
	0913	Hove to, release commands	0914	63°56·48'S	40°54·41'W
	0916	Released	0941	63°56·82'S	40°52·72'W
	1013	On surface	1002	63°56·99'S	40°52·98'W
3½ hrs	1024	Buoys sighted	1026	63°57·26'S	40°52·48'W
	1100	Grappled	1113	63°56·67'S	40°53·66'W
	1150	All inboard	1132	63°56·57'S	40°53·08'W

Re-deployment of Rig III

			Fixes	
1955/068/90	Hove to for	2012	63°55·58'S	40°59·20'W
	deployment	2044	63°55·87'S	40°59·38'W
2120	Mooring cut free	2108	63°55·90'S	40°58·98'W
2205	On bottom	2156	63°56·68'S	40°59·73'W

Deployment of Rig VIII

			Fixes	
0910/070/90	On station for	0924	62°04·25'S	40°35·92'W
	deployment	1016	62°04·37'S	40°36·22'W
1116	Mooring cut free	1045	62°04·43'S	40°35·83'W
1200	On bottom	1112	62°04·50'S	40°35·74'W

Recovery of Rig V

	1252/073/90	Start search		Fixes	
	1322	Hove to, release commands	1258	60°09·98'S	38°11·21'W
	1323	Released	1338	60°11·17'S	38°09·12'W
2 hrs	1353	Surfaced and sighted	1353	60°11·35'S	38°09·52'W
	1405	Grappled	1437	60°11·08'S	38°09·35'W
	1441	All inboard (+ fish eggs)			

Recovery of Rig VI

	2014/073/90	Start search		Fixes	
	2028	Hove to, release commands	2017	59°09·21'S	37°58·12'W
	2030	Released	2045	59°08·19'S	37°57·31'W
1½ hrs!	2057	On surface			
	2101	Sighted			
	2109	Grappled			
	2140	All inboard			

TABLE 3 Data return from current meters, recovered 1990.

Height above seabed	Mooring I	Mooring II	Mooring III	Mooring V	Mooring VI	Mooring VII
800 m	ℓ 6751 Tape jammed: no good data	ℓ 6749 Tape full	ℓ 6152 Tape full	▯ 9441 No data	▯ 9440 28 kbyte half year	▯ 9439 No data
50 m	ℓ 3261 Tape jammed: no data	ℓ 3257 Tape full	ℓ 3258 Tape full	▯ 9423 No data	▯ 9422 No data	▯ 9421 Flooded
10 m	ℓ 3259 ~ half tape	ℓ 8249 Tape jammed: no good data	ℓ 8247 Tape full	ℓ 8250 ~ half tape	ℓ 7063 ~ half tape	ℓ 6750 Tape jammed: no good data

ℓ = RCM-5 with magnetic tape
▯ = RCM-8 with solid-state DSU

TABLE 4 WHOI Sediment Trap Retrieval Data

Schedule created	02/06	1508	D15 878	Feb 6th i.e 037
Schedule retrieved	03/09	1830	B15 890	March 9th i.e 068

Valid data

Events = 15

Event	Date	Steps	Time	Status
0	02/06	31	1900	F0
1	02/07	90	1200	F0
2	03/06	90	1200	F0
3	04/03	90	1200	F0
4	04/31	0	1200	90
5	05/28	0	1200	10
6	06/25	0	1200	10
7	07/23	0	1200	10
8	08/20	0	1200	10
9	09/17	0	1200	10
10	10/15	0	1200	10
11	11/12	0	1200	10
12	12/10	0	1200	10
13	01/07	0	1200	10
14	02/04	0	1200	10

End of data

TABLE 5 CTD Stations

Station	Lat. S.	Long. W.	Time On	Time Off	Depth	Comments
890 CTD 032	60°11·45'	43°34·00'	1046/063/90	1452/063/90	5195 m	
890 CTD 033	60°19·23'	43°38·66'	2058/063/90	0117/064/90	5502 m	Mooring VII
890 CTD 034	63°02·80'	43°09·00'	2340/064/90	0213/065/90	3639 m	
890 CTD 035	63°21·30'	42°11·10'	0735/065/90	1010/065/90	3825 m	
890 CTD 036	63°10·30'	42°40·20'	1717/065/90	2032/065/90	3798 m	Mooring I
890 CTD 037	63°26·90'	41°55·80'	2234/066/90	0200/067/90	4745 m	
890 CTD 038	63°30·90'	41°46·00'	0302/067/90	0641/067/90	4552 m	Mooring II
890 CTD 039	63°46·60'	41°19·20'	2210/067/90	0206/068/90	4536 m	
890 CTD 040	63°55·50'	40°54·40'	0957/068/90	0811/068/90	4537 m	Mooring III
890 CTD 041	64°08·40'	40°21·20'	1348/068/90	1710/068/90	4621 m	
890 CTD 042	62°11·80'	40°13·40'	1851/069/90	2110/069/90	3300 m	
890 CTD 043	61°54·90'	40°57·40'	0045/070/90	0325/070/90	3530 m	
890 CTD 044	62°03·20'	40°34·90'	0631/070/90	0840/070/90	3312 m	Mooring VIII
890 CTD 045	60°21·20'	37°42·70'	0549/071/90	0753/071/90	2993 m	
890 CTD 046	60°11·30'	38°08·60'	1445/071/90	1730/071/90	2969 m	Mooring V
890 CTD 047	60°04·70'	38°26·60'	0922/073/90	1135/073/90	2845 m	
890 CTD 048	59°08·80'	37°57·60'	2256/073/90	0107/073/90	2870 m	Mooring VI
890 CTD 049	59°03·13'	37°24·20'	0351/074/90	0551/074/90	2895 m	
890 CTD 050	59°14·50'	38°35·00'	1048/074/90	1242/074/90	2893 m	

Extra CTDs for FRAM/WOCE

						Depth of cast
JB10	Event 844	55°58·60'S	40°26·60'W	1103/075/90	1200/075/90	1000 m
	845	55°37·00'S	40°00·80'W	1424/075/90	1510/075/90	1000 m
	849	55°15·05'S	39°32·75'W	1813/075/90	1902/074/90	1000 m
	852	54°53·60'S	39°05·40'W	2137/075/90	2225/075/90	1000 m
	855	54°31·00'S	38°38·80'W	0200/076/90	0220/076/90	210 m
	856	54°07'S	38°11·20'W	0601/076/90	0624/076/90	160 m

TABLE 6 XBT Stations

Event No.	Latitude S	Longitude W	Time
775	60°24·1'	43°36·32'	0215/064/90
776	60°31·5'	43°33·03'	0321/064/90
777	60°43·6'	43°28·50'	0514/064/90
778	61°05·0'	43°27·00'	0811/064/90
779	61°29·1'	43°23·16'	1028/064/90
780	61°53·0'	43°20·00'	1227/064/90
781	62°17·0'	43°17·0'	1462/064/90
782	62°41·0'	43°15·0'	1655/064/90
805	63°21·0'	40°44·0'	0400/069/90
806	62°47·0'	40°27.4'	0823/069/90
819	61°36·0'	39°51·7'	1520/070/90
821	61°07·0'	38°54·0'	1851/070/90
824	60°44·0'	38°20·0'	2320/070/90
830	59°38·0'	38°03·0'	1741/073/90
838	58°30·0'	38°44·0'	1757/074/90
839	58°00·0'	39°06·0'	2049/074/90
840	57°30·0'	39°27·0'	0025/075/90
841	57°00·0'	39°47·0'	0423/075/90
842	56°30·0'	40°08'	0820/075/90
843	56°00·0'	40°28·0'	1050/075/90
848	55°15·0'	39°32·0'	1905/075/90
847	55°30·0'	39°51·0'	1632/075/90
851	55°00·0'	39°13·0'	2045/075/90
854	54°30·0'	38°37·5'	0235/076/90
858	53°00·0'	39°00'	0210/077/90
859	52°30·0'	39°31'	0629/077/90
860	52°00·0'	40°10·4'	1046/077/90
862	51°29·0'	40°44'	1427/077/90
863	51°00·0'	41°00'	1721/077/90
864	50°30·0'	41°40'	2103/077/90

TABLE 7 Surface Water Samples

Sample No.	Latitude S	Longitude W	Time	Amount filtered litres
JB10/1	54°03'	54°58'	1715/060/90	2
JB10/2	55°00'	53°44'	0000/061/90	2
JB10/3	56°24'	52°03'	0855/061/90	2
JB10/4	57°04'	51°14'	1310/061/90	1
JB10/5	57°15'	50°01'	1420/061/90	1·25
JB10/6	58°03'	49°54'	1953/061/90	2
JB10/7	58°56'	48°50'	0135/062/90	1·25
JB10/8	60°16'	46°50'	1035/062/90	2
JB10/9	60°41·5'	46°07'	1347/062/90	2
JB10/10	60°47'	44°10'	0530/063/90	1·25
JB10/11	60°19'	43°36'	1810/063/90	2
JB10/12	60°44'	43°29'	0515/064/90	2
JB10/13	61°29'	43°23'	1025/064/90	2
JB10/14	62°17'	43°17'	1444/064/90	1·75
JB10/15	62°41'	43°15'	1650/064/90	2
JB10/16	63°03'	43°09'	0116/065/90	1·25
JB10/17	63°21'	42°12'	1015/065/90	1
JB10/18	63°31'	41°47'	0710/067/90	0·25
JB10/19	63°55'	40°56'	0516/068/90	1·25
JB10/20	63°56'	40°54'	0930/068/90	2
JB10/21	63°21'	40°44'	0400/069/90	1
JB10/22	62°46'	40°27'	0826/069/90	1
JB10/23	62°12'	40°14'	2040/069/90	0·50
JB10/24	61°55'	40°57	0330/070/90	2
JB10/25	62°04'	40°35'	0630/070/90	0·75
JB10/26	61°32'	39°43'	1550/070/90	1
JB10/27	61°07'	38°54'	1855/070/90	1
JB10/28	60°44'	38°20'	2320/070/90	1
JB10/29	60°20'	37°42'	0520/071/90	1·25
JB10/30	60°12'	38°07'	1640/071/90	2
JB10/31	60°05'	38°27'	1000/073/90	2
JB10/32	59°08'	37°57'	2145/073/90	2
JB10/33	59°03'	37°23'	0400/074/90	2
JB10/34	58°29'	38°44'	1800/074/90	2
JB10/35	58°00'	39°06'	2047/074/90	1·75
JB10/36	57°30'	39°27'	0025/075/90	2
JB10/37	57°00'	39°47'	0420/075/90	1·75
JB10/38	56°30'	40°08'	0820/075/90	1·50
JB10/39	56°00'	40°28'	1050/075/90	2
JB10/40	55°30'	39°52'	1629/075/90	1·75
JB10/41	55°00'	39°13'	2045/075/90	2
JB10/42	54°30'	38°37·5'	0232/076/90	1
JB10/43	53°00'	39°00'	0210/077/90	1
JB10/44	51°56'	40°16'	1120/077/90	1
JB10/45	51°00'	41°00'	1721/077/90	1

Table 8. Depths of water samples for oxygen isotope analysis at CTD stations 033, 036, 038, 040, 044, 046 and 048.

033	036	038	040	044	046	048
1500	1000	1000	500	500	500	500
3000	2000	1500	1000	1000	1000	1000
1000	1000	2500	2000	1500	1500	1500
800	800	1000	3000	2000	1000	1000
600	600	800	1000	1000	800	800
400	400	600	800	800	600	600
200	200	400	600	600	400	400
10	10	200	400	400	200	200
		10	200	200	10	10
			10	10		

Total 63

TABLE 9 Z-Nets

Event No.	Depth	Latitude S	Longitude W	Time	Comments
772	150 m	60°19·2'	43°38·7'	1615/063/90-1645/063/90	Mooring VII
788	150 m	63°10·3'	42°40·2'	1405/065/90-1445/065/90	Mooring I
790	600 m	63°30·9'	41°46·0'	1900/066/90-2030/066/90	Mooring II
794	150 m	63°30·9'	41°46·0'	1730/067/90-1750/067/90	Mooring II
799	150 m	63°55·5'	40°54·4	0940/068/90-1005/068/90	Mooring III
807	150 m	62°11·8'	40°13·4	1200/069/90-1235/069/90	
808	600 m	62°11·8'	40°13·4'	1500/069/90-1650/069/90	
818	150 m	62°03·2'	40°34·9	1125/070/90-1155/070/90	Mooring VIII
829	150 m	60°11·3'	38°08·6'	1330/073/90-1350/073/90	Mooring V
832	50 m	59°08·8'	37°57·6'	2040/073/90-2100/073/90	Mooring VI
846	150 m	55°37·0'	40°00·8	1515/075/90-1544/075/90	

JOHN BISCOE JB10/3

TRACK CHART